PATENT SPECIFICATION (11) 1 571 289

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(21) Application No. 50670/76 (22) Filed 6 Dec. 1976
(31) Convention Application Nos. 640 700 and 640 696
(32) Filed 15 Dec. 1975 in
(33) United States of America (US)
(44) Complete Specification published 9 July 1980
(51) INT CL³ B65H 81/08, 54/02, 55/04//54/30
(52) Index at acceptance
B8G 1C 4
B8M 3C RB
D1J 112 137 139 209 GC

(19)

(54) A METHOD AND APPARATUS FOR WRAPPING MULTIPLE TAPES UPON AN ELONGATED STRUCTURE

(71) We, THE MAGNA-PLY COMPANY, a joint venture organized under the laws of the State of Connecticut, United States of America, of 129 Soundview Road, Guilford, Connecticut, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to supply packages of tape material which are sometimes referred to in the trade as spools or cops. Additionally, the invention relates to the traverse winding of a plurality of individual tapes into a package. The invention further relates to a method of and apparatus for wrapping elongated structures such as electrical conductors or cables with a plurality of individual tapes from the package of the invention. The invention also relates to the field of tape-wrapped constructions.

In the past a variety of different methods and machines have been used for the wrapping of tape material around a length of an electrical conductor or cable. One of the methods used is the wrapping of the conductor with a single tape supplied from a pad. A pad is flat roll of tape with each turn of tape thereon completely overlapping a prior turn. In wrapping, the pad is revolved concentrically or eccentrically about the circumference of the conductor to be wrapped while the conductor is advanced along its longitudinal axis. This method although quite reliable is inherently limited in rate of production since the speed of rotating the pad flyer or winding head which carries the tape pad and winds the tape around the conductor is limited by the maximum speed which the pad can withstand as it is revolved around the conductor. Overlapping of each wrap of tape also effects the production rate. For example, if a fifty percent overlap of tape on the conductor is desired the conductor must be advanced at a slower speed as compared to that where a ten percent overlap is desired.

It is also known in the art to wrap tapes around a construction such as conductor from two or more separate pads concentrically or eccentrically mounted on a common winding head. Thus, the different tapes are applied from a plurality of pads at a single station in a rotational manner with respect to the length of the conductor or cable being wrapped. This method results in the first of a plurality of different tapes being wrapped directly around the conductor, the second tape of the plurality being wrapped directly around the first tape, and so forth. Since the length of tape on each of a plurality of pads will vary one from another, one pad becomes exhausted of tape before the others. Since it then becomes necessary to shut down and reload the wrapping machine with all new pads of tape, the tape remaining on the unexhausted pads is simply wasted.

Still another method known in the art is to wrap one or more single tapes around a conductor or cable by the use of pads of single tapes mounted on a plurality of different winding heads disposed at different stations spaced along the line of travel of the conductor or cable being wrapped. This method enables more layers of tape to be applied during a single pass of the conductor through the plurality of winding heads.

Whether a winding head carries one or a plurality of pads, the pads of tape are subjected to high rotational speed in being revolved concentrically or eccentrically around the longitudinal axis of the cable. Accordingly, the tape pads must be capable of withstanding an appreciable level of centrifugal force during the wrapping operation without coming apart. If the tape being used is comparatively narrow and if wound in a completely overlapping manner, the pad is quite unstable and can easily fall apart from the core upon which it is wound. A pad having each layer of tape completely overlapping adjacent layers necessarily requires a large diameter pad for a large supply of tape. Due to the maximum diameter of a pad which a wrapping machine

is capable of accepting, the time period of operation is severely limited by the length of tape which can be mounted on the winding head, thus limiting the length of conductor which can be wrapped before stopping the head to install new pads.

These problems have been reduced by winding the tape packages in a traverse manner, that is to say the turns of tape advance along the length of the package alternately from one end to the other thereof. Thus as one end of the package is reached by the winding of the tape, the tape is wound toward the opposite end of the package. Traverse winding of the tape packages enables an appreciable length of tape material to be furnished in a single package without having the excess diameter for the same length of tape material which would result if the tape was wound in a fully overlapping fashion into a pad. Also, a tape package which is traverse wound can better resist centrifugal and windage forces at high winding speeds.

U.S. Patent No. 533,934, which issued on February 12, 1895 discloses a traverse wound cop having a plurality of parallel threads wound in a traverse manner. This patent also discloses an apparatus for winding the cop which includes a feed mechanism and friction wheel for varying the rate of movement of the threads in the traverse direction as the diameter of the cop increases during winding.

U.S. Patent No. 2,372,400, which issued on March 27, 1945, discloses traverse winding of strands or yarns of fibres of silk, cotton or the like, wherein one turn of a plurality of adjacent strands is partially overlapping upon the previous turn of a plurality of adjacent strands in order to interlock the strands on the package.

Machines for wrapping electrical conductors with a plurality of tapes each from a different pad of tape are manufactured by Aimco Division of The Entwistle Company, Bigelow St. Hudson, Mass. 01749. This company manufactures a Concentric Pad Type Taping Machine in which a single flyer or winding head at a single taping station carries as many as four pads, each having a single tape, mounted concentrically with the axis of rotation of the winding head. Such a machine can wrap a conductor with a pair of tapes from one pair of pads in an overlapping relationship such as half lapped and a second pair of tapes from another pair of pads, again in an overlapping relationship such as half lapped.

The Aimco Division manufactures an Eccentric Pad Type Tape Machine having a winding head with a number of different pads mounted about the periphery of the head with each pad having a single tape. Such a machine can apply, by way of example, four different tapes, each from a different one of four separate pads.

Aimco Division also manufactures a Concentric Cop Type Tape Machine which wraps a single tape from a traverse or universal wound supply package having its core disposed about the axis of rotation of the winding head.

An object of the invention is to provide a tape supply package having a plurality of individual tapes traverse wound thereon.

Another object of the invention is to provide a method and apparatus for winding the tape supply package of the invention.

A further object of the invention is to provide machine and method for simultaneously applying a plurality of individual tapes to an elongated structure such as an electrical conductor.

An additional object of the invention is to provide a wrapping on an elongated structure in which the wrapping comprises two or more individual tapes simultaneously applied to the structure.

According to a first aspect of the invention, there is provided a method of wrapping tape material in a helical manner about a length of an elongated structure, the tape material comprising a plurality of individual tapes from at least one tape supply package having a plurality of individual tapes traverse wound thereon, the method comprising the steps of:

a) advancing the elongated structure to be wrapped in a predetermined direction;

b) rotating the or each tape supply package with respect to the line of advancement of the elongated structure;

c) separating each one of the plurality of tapes from the or each tape supply package at a predetermined location on the periphery of the rotating package;

d) guiding each tape of the plurality of individual tapes from the or each tape supply package toward the elongated structure to be wrapped thereabout, each tape being guided for wrapping on the elongated structure at a predetermined helical angle with respect to the length of the elongated structure and for wrapping with respect to the next adjacent tape of the plurality of tapes in either spaced apart or substantially abutting, or overlapping relationship; and

e) wrapping helically the guided tapes on the elongated structure in spaced apart or substantially abutting, or overlapping relationship.

According to a second aspect of the invention, there is provided a wrapped elongated structure obtained by the method of the first aspect of the invention and comprising a plurality of individual tapes wrapped adjacent one another in a helical manner along a length of an elongated article with the tapes being spaced apart or abutting, or overlapping relationship.

According to a third aspect of the invention, there is provided a machine for wrapping

tape material in a helical manner about an elongated structure by the method of the first aspect of the invention, the machine having a winding head, means for driving the head about an axis of rotation of the winding head, the head having an opening extending therethrough along the axis of rotation, means for advancing an elongated structure to be wrapped through the opening in the head in a direction extending substantially along the axis of rotation, a support attached to the winding head for supporting thereon a supply package of traverse wound tape material, a plurality of means attached to the winding head and disposed in circumferentially spaced apart relationship to one another around and adjacent a periphery of the winding head for separating an individual tape of a plurality of individual tapes traverse wound on the tape supply package mounted on the support, each of the separating means causing an associated one of the plurality of tapes to leave the package at a predetermined location adjacent the periphery of the package, the line of travel of each separated tape cyclically varying in direction in response to the traverse winding of the plurality of tapes on the package, and a plurality of guides each for guiding an associated one of the tapes to be wrapped at a predetermined helical angle with respect to the length of the elongated structure and for guiding an associated one of the tapes in spaced apart or substantially abutting or overlapping relationship to the or each next adjacent tape, each of the guides being mounted on the wrapping head circumferentially spaced apart from the or each other guide and being disposed around the axis of rotation of the head at a location axially spaced from the support.

According to a fourth aspect of the invention, there is provided a supply package of tape material to be helically wrapped about a length of a structure by the method of the first aspect of the invention comprising a plurality of individual tapes of substantially equal length, traverse wound in turns about a longitudinal axis of the package to form a plurality of tubular layers, each layer being wound about the layer previously wound, each tape in a turn of the plurality of tapes in each layer overlapping the next adjacent tape, the overlapping being overlapping of the width of the tape next adjacent thereto by a predetermined amount less than the total width of the tape, whereby the plurality of tapes can be wrapped around a length of an elongated structure without the creation of a surplus or shortage in any of the plurality of tapes.

According to a fifth aspect of the invention there is provided a machine for winding a supply package of tape material in accordance with the fourth aspect of the invention, the machine having means for supporting the package in rotation as it is being traverse wound, means spaced apart from the supporting means for guiding tape advanced from a supply of tape to a package being wound, and means for reciprocating the guiding means in a direction extending substantially parallel to the axis of rotation of the package supporting means to cause the tape to be traverse wound upon the package, the tape guiding means comprising a plurality of passages each of which is adapted to receive an associated one of a plurality of tapes to be traverse wound in overlapping relationship, the passages in the guiding means extending substantially parallel to one another and being positioned with respect to one another in correspondence to the required overlap, the passages of the guiding means enabling the plurality of tapes to be delivered to the package with a required overlap to be traverse wound to form the package.

According to a sixth aspect of the invention, there is provided a method of winding a supply package of tape material in accordance with the fourth aspect of the invention, comprising the steps of traverse winding a tape to form a plurality of tubular layers, each layer being disposed about the layer previously traverse wound, positioning each turn of tape in a layer during the traverse winding to overlap a predetermined portion of the width of the tape in the turn of tape adjacent thereto, the predetermined portion of overlapping being less than the total width of the tape, supporting the package in rotation as it is being traverse wound, and guiding the tape when being advanced from a supply of tape to a package being wound, the guiding including recipcrocating the tape being advanced in directions extending substantially parallel to the axis of rotation of the package to cause the tape to be traverse wound upon the package, wherein an improvement comprises the steps of providing a plurality of individual tapes of substantially equal length to be traverse wound, during the guiding step placing each tape overlapping with respect to the next adjacent tape thereto, the overlap being by an amount which is less than the total width of the tape, and during the traverse winding step maintaining the overlapping relationship of the tapes.

For a further understanding of the invention reference is made to the following description taken in connection with the accompanying drawings of preferred embodiments of the invention in which:—

FIG. 1 is a perspective view of a multiple tape guide device for use with a mulitple tape supply package mounted on a winding head of a wrapping machine;

FIG. 2 is a side elevational view of the guide device with the multiple tape supply package mounted on the winding head;

FIG. 3 is a front elevational view of the

guide device showing threading of tapes from a multiple tape supply package;

FIG. 4 is a perspective view of the guide device with two guides for simultaneously guiding two tapes from a two tape supply package;

FIG. 5 is a perspective view of the guide device with four guides for simultaneously guiding four tapes from a four tape supply package;

FIG. 6 is a fragmenraty view of an individual guide block showing the variation of tape delivery angle;

FIG. 7 is a perspective view of a section of an elongated rectangular conductor being wrapped with two partially overlapping tapes applied simultaneously;

FIG. 8 is a vertical section view of a single tape flat wound tape supply pad of the prior art;

FIG. 9 is a side elevational view of a single tape traverse wound tape supply pad of the prior art;

FIG. 10 is a side elevational view of a partially overlapping, two tape, traverse wound tape supply package of the invention;

FIG. 11 is a side elevational view of a partially overlapping, three tape, traverse wound tape supply package of the invention;

FIG. 12 is a side elevational view of a partially overlapping, four tape, traverse wound tape supply package of the invention;

FIG. 13 is a vertical section view of a first tape wrapped about an elongated conductor and a second tape wrapped about the first tape by employing a method known in the prior art;

FIG. 14 is a vertical section view of an elongated conductor wrapped with two partially overlapping tapes from a traverse wound tape supply package in accordance with the invention;

FIG. 15 is a vertical section view of an elongated conductor wrapped with three partially overlapping tapes from a traverse wound tape supply package of the invention;

FIG. 6 is a vertical section view of an elongated conductor wrapped with four partially overlapping tapes from a traverse wound tape supply package of the invention;

FIG. 17 is a perspective view of the front of a winding apparatus having an overlapping multi-feed head for traverse winding partially overlapping multiple tapes into a tape supply package of the invention;

FIG. 18 is a perspective view of the side of the winding apparatus having an overlapping multi-feed tape head to simultaneously traverse wind partially overlapping multiple tapes into the tape supply package of the invention;

FIG. 19 is a schematic drawing of the drives of the apparatus shown in FIGS. 17 and 18;

FIG. 20 is a perspective view of a two tape feed guide of the invention;

FIG. 21 is a vertical section view of a two tape feed guide of the invention;

FIG. 22 is a vertical section view of a four tape feed guide of the invention;

FIG. 23 is a side elevational view of a traverse wound tape supply package of the invention having a plurality of individual tapes substantially abutting one another;

FIG. 24 is a side elevational view of a traverse wound tape supply package in which the individual tapes of the plurality of tapes are spaced from one another;

FIG. 25 is a schematic representation of a tape winding apparatus in accordance with the invention having a provision for eccentrically mounting a plurality of tape supply packages, each having a plurality of individual tapes and provisions for wrapping the individual tapes around a conductor;

FIG. 26 is a schematic representation of a tape winding apparatus in accordance with the invention having a plurality of traverse wound tape supply packages each having a plurality of individual tapes, offset from the axis of rotation of the winding head with the core of each supply package extending substantially parallel to the axis of rotation of the winding head; and

FIG. 27 is a vertical section view of an elongated conductor wrapped with two pairs of two partially overlapping tapes each from individual traverse tapes on supply packages.

In the embodiment described herein, the method and apparatus of the invention is employed to wrap tape around an electrical conductor being in a strip-like form having a rectangular cross-section. The method and apparatus can be used in wrapping elongated constructions having various different traverse cross-sections. By way of example, the conductor bieng wrapped is of the type used in the windings of a power transformer of the type used by a public utility. The conductors are wrapped with layers of tape in order to prevent contact of one conductor within the transformer with another. Thus, in a typical application the wrapped conductors are separated by the wrapping and are electrically insulated from one another by the tape wrapping and by transformer oil surrounding the conductors. In such an application the tape material can be rope fiber which comprises approximately 90% hemp material and 10% pulp material, kraft paper, or other suitable insulating materials. Thermally upgraded rope fiber material and various other papers which can withstand a temperature rise of approximately 65°C can also be used. In addition, where higher temperatures are encountered, the conductors can be wrapped with tape insulating material, one type of which consists of nylon fibers and is marketed by E. I. DuPont DeNemours of Wilmington, Delaware, under the trademark NOMEX.

Depending upon the particular application, the multiple partially overlapping tapes can be applied by one or more winding heads of the wrapping machine. For example, a wrapping machine having double winding heads can be provided with a tape supply package of four tapes on the first winding head and a tape supply package of three tapes on the second winding head. As a result the conductor is wrapped with a total layer of seven tapes comprising the sum of four overlapping tapes plus three overlapping tapes. Various combinations of the number of tapes in each multiple tape supply package and the number of winding heads on the wrapping machine provide an appreciable range of the number of total tapes which can be applied to the conductor during a single pass through the wrapping machine. The total number of tapes could extend to at least as high as 65 or 70 tapes.

Referring now more particularly to the accompanying drawings wherein like numerals designate similar parts throughout the various views, attention is directed first to FIG. 1 wherein the guiding head 20 of the present invention is shown mounted on a winding head of a cable or conductor wrapping machine. The guiding head 20 of the present invention comprises two circular end plates 22 and 23. These end plates are connected to one another in axial alignment and parallel to one another by a plurality of rods 24. In the center of end plates 22 and 23 which can be formed of having a low coefficient of friction are apertures 25 and 26, respectively. The apertures are in axial alignment with one another and are of a size to receive and yet clear the elongated conductor 35 being wrapped as the conductor passes through them. Slidably mounted on rods 24 are guide holders 28. The guide holders are adapted to be positioned along rods 24 and then to be locked in a predetermined position relatively to each other by means of set screws 29. The position at which the guide holders 28 are positioned and secured on rods 24 relative to each other determines the amount of overlap between the tapes when they are wrapped around the elongated conductor. Guides 30 in turn are pivotally mounted on guide holders 28 to enable the taping angle at which the guides feed the tape to the elongated conductor to be varied. The taping angle, which is the acute angle between the longitudinal axis of the conductor and the longitudinal axis of the tape, is determined by the extent or percentage of the tape partial overlap which is desired.

The guiding head 20 is mounted concentrically on the winding head 21 of the wrapping machine, which drives the guiding device. The winding head carries multiple tape supply package 31. Guide pins 32 for directing the different individual tapes to their respective guides 30 are pivotally mounted on support rods 21a extending from flange 21b of the winding head. The ends of support rods 21a are supported by cap screws 21c extending through holes in ring 21d of the winding head. Rollers 33 are rotatably mounted along their longitudinal axis on shafts 34. Each roller 33 is substantially cylindrical along its length and has a circular transverse cross-section. The diameter of the cross-section is maximum at the opposite ends of each roller 33 and minimum in the central portion to provide a concave surface on each roller for accommodating the cyclical varying direction of the line of travel of the associated tape on separation from the package. These rollers function to support the individual tapes being delivered from the multiple tape supply package to their respective guide pins and guides.

As indicated by the arrow in FIG. 2, the elongated conductor 35 being wrapped is moved along its longitudinal axis through the winding head 21 and guide device 20 by means of a driving means (not shown). Guide rollers 40 and 40a position and support the conductor as it advances through the guide device and into tubular support 40b. The driving means is located to the left of the end of support 40a as shown in FIG. 2. Also shown in FIG. 2 are variable length bushings of low friction material 36 and 37 located within the end plates 22 and 23 which serve to guide the elongated conductor if it should momentarily sag or otherwise approach contact with the guide device.

Referring to FIG. 3, the threading of the individual tapes can be seen. Thus, tape 31a is taken from the two tape supply package 31, first at point 41. It is then threaded over a pair of concave rollers 33 and is wrapped around guide pin 32 which directs the tape onto guide 30 and to the elongated conductor 35. Tape 31b is similarly passed over a different pair of concave rollers 33, guide pin 32, and guide 30 to the conductor. The rollers 33 are spaced apart from one another and are spaced from the axis of the winding head in a radial direction.

When setting up the machine for operation, a multiple tape supply package 31 is slipped over the center spindle 42 of the winding head 21. The guide device which is secured to the center spindle 42 by means of set screws 43, as shown in FIG. 1, has an outside diameter smaller than the inside diameter of the core of the supply package. The multiple tapes are then threaded as discussed above and the ends thereof are attached to the elongated conductor by means of any suitable adhesive. The machine is then started. It should be noted that the guide device 20, guide pins 32, concave rollers 33, tape supply package 31, and the center spindle 42 of rotating head 21 are all in a fixed position relative to each other throughout the full arc of rotation about the center line of

the conductor. As a result, all rotate concentrically about the longitudinal axis of the elongated conductor as the elongated conductor is pulled through the center of the rotating head by the drive means of the wrapping machine at a variable selected speed directly proportional to the rotating speed of the guide head.

FIG. 4 shows a two-tape guide device 20, while FIG. 5 shows a four-tape guide 20a. The configuration and number of support rods 24 varies as a direct function of the number of tapes on the supply package. For example, a six-tape supply package, that is a supply package having six partially overlapping tapes, would have six support rods extending between end plates 22 and 23 and spaced apart from one another by arcs of 60°. Such a configuration could also be used for a tape supply package having three partially overlapping tapes. Theoretically, such a device could be used for application of two, three, four, five or six tapes; however, as a practical matter, for better dynamic characteristics at the relatively high rotating speeds of the winding head, it is preferred to have guides 30 on guide device 20 in a symmetrical and consequently dynamically balanced configuration as shown in FIGS. 4 and 5.

The guides 30 as used in the present invention can be formed from a material which has a minimal coefficient friction with the tape material, such as nylon resin material, while the support shafts 24 can be formed of polished steel.

Referring to FIG. 6 wherein a detail view of a tape guide 30 is shown, it should be noted that the tape receiving end 30a of the slot 30b of the guide is tapered outwardly. It should also be noted that the angle at which the tape can be delivered to the guide 30 from the guide pin 32 can vary through a tape delivery angle designated 30c. The possible range of the tape delivery angle 30c from guide pin 32 is caused by the constant change of the angle of issuance of each of the multiple overlapping tapes from the supply package during operation. The change in the angle of issuance is due to the fact that the tapes are traverse wound on the supply package and the diameter of the package at any instant during unwinding affects the issuance of angle. Hence, the function of the funnel-shaped receiving end is to accommodate the variable tape delivery angle from the guide pin 32. Tape guides 30 may then deliver the tape at a constant taping angle to the elongated conductor.

The taping angle is a function of the selecting of the degree of overlap for the multiple tapes and the geometry and size of the cross-section of the conductor being wrapped.

The slot in each of guides 30 may be varied in width to fit different widths of tape. For a limited range of different uniform tape sizes, different guides 30 are made available for whatever tape size is desired. As can be seen from FIG. 4 and 5, guides 30 are secured to guide holders 28 by means of fasteners 43 and therefore can be readily interchanged.

By using the apparatus and method of the invention, it is possible to increase the production rate of wrapping conductors since the length of the tapes along the longitudinal axis of the conductor for each rotation of the winding head can be increased without increasing the head speed. As a result the rate of travel of the conductor through the machine is increased. The extent to which the speed of the conductor can be increased depends upon the number of tapes from the multiple tape supply package that are being simultaneously applied. For example, using a 1/2 inch wide single tape supply of the prior art with a selected overlap of 50% on the conductor, the conductor would advance an increment for each complete rotation of the winding head which is a function of the tape width and an inverse function of the taping angle. If however, a four-tape supply package is used, in accordance with the invention, the conductor would be advanced four times the increments of the single tape for each complete rotation of the winding head.

As can be seen by comparing FIGS. 13, 14, 15 and 16, a feature of the multiple tape wound conductor is that each of the multiple tapes of the invention are applied with a portion of each in contact with the conductor regardless of the number of tapes being applied. Thus, in each of the three constructions shown in FIGS. 14, 15 and 16, one edge portion of each tape is in contact with the surface of the bare conductor and is progressively laid over each of the other tapes coming from the multiple group of tapes wound on the supply package. In FIG. 13 only tape 31e contacts the conductor while tape 31f simply overlies tape 31c.

By use of a multiple station winding machine, the output of more than one multiple tape package may be simultaneously and consecutively applied about the conductor. A double-headed machine, for example, may have on its first winding head a four-tape supply package while on its second winding head may have a three-tape supply package. The resulting number of layers of tape would be seven, the sum of a four-tape construction plus a three-tape construction.

FIG. 13 shows a conductor which has been double wrapped by using two single tapes of the prior art and running the conductor through the winding machine twice or through two separate winding stations or through two tape pads a single head winding machine having two tape pads either concentrically or eccentrically mounted thereon. Such a

machine would overlap one tape upon another to the extent of about 50% of the width of the tape. FIG. 16 shows a conductor wrapped according to the present invention using a four-tape supply package. A comparison of the two shows that although there exists substantially the same total thickness of tape covering the conductor, the latter can be obtained by simply running the conductor through a single winding head in accordance with the invention while the arrangement of the prior art shown in FIG. 13 requires either two passes through a single winding head, through two separate winding heads, or through a winding head having two separate pads. The resulting pattern of the multiple tapes in FIG. 16 has the advantage that each of the different tapes are in engagement with all of the other tapes. The pattern has the further advantage that it can accommodate bending of the conductor because the nested multiple tapes can each comply to the movement of the others. The pattern resulting in FIG. 13 has no such engagement between the individual tapes. Instead, one tape is simply wrapped on top of the other.

The apparatus and method of the invention can use a supply package or packages in which the tapes are wound in abutting or spaced apart relationship, as described hereinafter with reference to FIG. 24.

By way of example, tapes used in wrapping electrical conductors for electrical power equipment have standard widths in a range extending upwardly from approximately .375 inches in increments of .125 inches. Such a range can extend up through a tape width of at least 1.250 inches. Tapes in this range of tape widths can be used with various sizes of conductors such as round conductors in a range extending upwardly from about .808 inches in diameter and through a range of rectangularly shaped conductors extending from about .124 inches wide to about 1.25 inches wide and in thickness from .030 inches to .250 inches. In accordance with the invention, even thicker and wider structures than these can be wrapped with multiple tapes.

Further by way of example, the conductors to be wrapped in accordance with the invention can be various round, square or rectangular conductors having cross-sectional areas in the range from about .0051 square inches to about .4420 square inches. Much larger cross-sectional areas than these can also be wrapped with multiple tapes in accordance with the invention. The wrapped cable or construction of the invention is not limited to this range; however, this range is indicative of the present commercial range for tape-covered magnet wire used in industry which can be wrapped in accordance with the invention.

When wrapping an elongated conductor using a single tape supply, whether it be a flat wound or traverse, the tape will simply issue forth as needed. If an attempt was made to wrap a conductor with two different tapes from a single package on which the tapes were not simultaneously wound, an insurmountable problem would result. The problem would be that a difference in the length of the tape being taken from one of the two separate windings on a common core would result. As soon as the differences existed, either one tape would break, or slack in the other tape would result.

As is well known in the art, if two or more tapes are simultaneously wound around the core of a supply package such that they are 100% overlapping, the tape which is outside for each turn about the core would be longer than the other tape. Hence, if the multi-tape supply package described above were applied to a conductor, there would be an excess length or shortage of one tape relative to the other. This would cause an uneven winding and eventually breakage or tangling of the excess tape within the rotating head lead.

The partially overlapping multi-tape supply package of the invention has succeeded in eliminating these problems of wrapping multiple tapes from a single supply. Thus in accordance with the invention simultaneously traverse winding of multiple tapes on a single core with the same nominal degree of overlap as is to be on the wound conductor enables the multiple tapes to be wrapped without accumulating a surplus or shortage of any tape. For example, if a conductor is to be wrapped with three tapes simultaneously with each overlapping the tape adjacent thereto by one-third of its width, then a tape supply package containing three tapes with a corresponding overlap may be used. In this way it is ensured that when the three tapes are taken from the supply package they will all be of equal length.

FIG. 8 shows a prior art single tape supply pad flat wound on a hollow core. FIG. 9 depicts a prior art single tape supply pad traverse wound on a hollow core to form a spool or cop. FIG. 10 shows a two-tape partially overlapping traverse wound tape supply package 31 of the invention. In package 31 of FIG. 10, tape 31a is of the same length as that of tape 31b since neither tape 31a nor 31b in package 31 is consistently closer to the core than the other. If a pair of the prior art pads were to be used or the pad of FIG. 8 was to be provided with mulitple tapes, a surplus or shortage of either tape would necessarily occur. The invention eliminates this problem.

FIG. 11 shows a three-tape supply package 31′ of the invention. It can be seen that one part of each of individual tapes 31′a, 31′b, 31′c is partially overlapping the tape adjacent

to it with the result that the other part of the tape is in direct contact with the layer of tapes beneath. For example, the left side of tape 31'b is partially overlapping the right side of tape 31'a as viewed in FIG. 11. Thus the right side of tape 31'b is in contact with the layer beneath it and is being itself overlapped by tape 31'c. On the next layer of the three tapes, the left side of tape 31'a will partially overlap the right side of tape 31'c. Hence all three tapes are in partial contact with the layer below and are overlapping each other in the same amount. Accordingly, all three tapes in the set are at any instant wound about the same diameter and this results in each of the tapes being of equal length.

FIG. 12 shows a supply package 31'' of the present invention containing four individual tapes, all being of equal length.

Any of the supply packages 31, 31' or 31'' of FIGS. 10, 11 or 12 can be wound on a tubular core for supporting the package during handling and providing a mount for the package during supply of tapes therefrom. Alternatively, no such core may be provided, the package being provided with a substantially hollow central portion which provides the mount.

The amount of overlap in the tapes wound on the package may vary between overlapping of edge portions of adjacent tapes only to overlapping of a major portion of adjacent tapes.

FIGS. 17, 18 and 19 disclose apparatus which can be used to wind a partially overlapping, abutting or separated traverse wound, multi-tape supply package 31. Winding machine 49 comprises a modification of a winding machine used in the prior art to traverse wind a single tape into pads. In FIGS. 17 and 18 and more particularly in FIG. 19 which is a schematic view of the tape feed of machine 49, it can be seen that power source or motor 50, by means of a belt rotates drive roller 51 by means of drive 50a and shaft 52. The roller 51 can be formed of rubber-like material to provide adequate friction with respect to the package to rotate it throughout the winding process. Supply package 53 is mounted on spindle 54 and is biased against the roller 51 by means of weight 55 (FIGS. 17 and 18). This ensures that the layers are compressed as they are wound to maintain the package intact during handling. Spindle 54 by means of chains and sprockets 56 rotates cylindrical cam 63 which in turn transmits horizontal movement to pivotally mounted lever 57 (FIG. 19) by means of following 58 engaged with cam track 62. Pivotally mounted lever 57 in turn moves a guide holder 59 which is slidably mounted on bars 60 (FIGS. 17, 18 and 19) extending parallel to the axis of package rotation. Removably attached to the guide holder 59 is multiple tape guide head 61 of the invention.

Guide head 61 as shown in FIGS. 20 and 21 contains two narrow parallel passages 64 each of which extends through the length of the head. These passages are adapted to guide the individual tapes 31a and 31b to be wound on the multiple tape supply package 31 and their width corresponds substantially to the width of the tapes 31a, 31b. As can be seen from FIGS. 20 and 21, the passages 64 extend through the head in different planes and are partially overlapping each other. The degree of overlap can be selected to correspond substantially to the degree of overlap of the multiple tapes when wound on the conductor. This may range between overlapping of edge portions of adjacent tapes to overlapping of the major portions of adjacent tapes. Thus guide head 61 is conditioned by not only the number of tapes to be wound on a package, but also by the amount that the tapes are to overlap each other.

In operation of the winding apparatus as shown in the drawings, two tapes are threaded through the tape guide head as shown in FIG. 19. The tapes are delivered to machine 49 from two separate supply sources (not shown) which can be flat-wound pads or rolls of tape. The tapes 31a and 31b are then threaded under drive roller 51 and between a core mounted on spindle 54 and the rear side of roller 51. The tapes are then attached to the core. The power source 50 is then energised. Since the tapes and core are forced against the rear side of drive roller 51 as seen in FIGS. 17—19, rotation of roller 51 in the direction of the arrow rotates the core by friction engagement. The rotation of the core on spindle 54 causes tapes 31a and 31b to be pulled from their individual supply packages and to be wound around the core. The individual tapes after passing through guide head 61 are aligned in a partially overlapping fashion and will be wound in that manner on the core. Guide head 61 can be formed from low friction material such as resin materials which are suitable for bearing the running tapes.

At the same time as the tapes are being wound on the core, the rotation of the cam drum 63 will cause the lever 57 to move the guide head 61 back and forth across the surface of rubber roller 51. This horizontal movement will result in the tapes being traverse wound upon the core of the supply package. Since the drive to cam 63 and thereby arm 57 which carries the guide head originates with spindle 54, it can be seen that the movement of the guide head is synchronized with the surface speed of the package or the core regardless of the instantaneous diameter of the pad. In this way the number

of turns of overlapping combinations of tapes is the same for all layers of the traverse wound package.

FIG. 22 depicts a four tape feed guide head of the present invention. By way of example, four-tape packages in accordance with the invention have been prepared by the use of paper tape one-half inch in width and approximately .0025 inches thick. The traverse wound package is formed about a core approximately three inches in diameter with a package width of approximately three and one-half inches and an outside diameter of approximately eight inches. The degree of overlap of adjacent tapes can be, in the example, approximately seventy-five percent. An eight inch diameter package would include approximately thirty-three hundred total yards of tape. A ten and one-half inch package of this type would contain approximately sixty-six hundred total yards while a twelve and one-half inch package would include approximately ninety-nine hundred yards.

Further in accordance with the invention, the supply package can comprise a plurality of different tapes which are traverse wound with the edges of each different tape substantially abutting the tape adjacent thereto. Thus, the plurality of different tapes are not overlapping in the supply package. As shown in FIG. 23, supply package 70 comprises traverse wound tapes 70a, 70b, and 70c which have their edge portions in an abutting arrangement. Thus, in supply package 70, the plurality of tapes are not overlapping one another. Tapes 70a-c can be applied to an elongated conductor by the method and apparatus of the invention for wrapping tapes. In wrapping tapes 70a-c, the different tapes can be applied to the conductor in an abutting, separated, or overlapping arrangement as determined by the setting of the guide device of the winding head.

In the traverse wound supply package the plurality of tapes making up the package can have their edge portions abutting or spaced apart from one another. As shown in FIG. 24, supply package 71 is formed by different tapes 71a and 71b which are traverse wound with their adjacent edges spaced apart from one another by an interval designated "X" in the drawing. Although it is possible for the interval X between the different tapes being traverse wound to be greater than the width of a tape designated "W" in FIG. 24, it is preferred than interval X be less than the tape width W. Such tapes can be wound on an elongate structure with the tape abutting or spaced apart along the conductor by an amount greater or less than the tape width.

In the art it is known to mount a plurality of pads of tape on a flyer or winding head eccentrically with respect to the axis of rotation of the head. In such an arrangement the plurality of flat pads have been mounted with the flat side of the pad facing the axis of rotation of the winding head and the conductor being wrapped. Thus, the axis of the pad about which the tape is wound thereon extends at substantially a right angle with respect to the axis of rotation of the head. The winding head and tape package of FIG. 1 can be so eccentrically mounted as described hereafter with reference to FIGS. 25 and 26. As shown in FIG. 25, in accordance with the invention, the winding head 72 comprises a base portion 73 and supports 74 extending at a converging angle with respect to one another from the face of the base portion. Spindles 75 extend from each of supports 74 and are each adapted to support a different traverse wound multiple tape supply package 76 thereon. Guides 77 direct the plurality of tapes 76a' and 76a'' from the supply packages as the plurality of tapes from each different package are simultaneously wrapped about conductor 78. The resulting configuration of tapes is shown in FIG. 27. Since supports 74 extend toward one another and at an angle to base 73, the distance which the traverse wound multiple tape supply packages extend outwardly in a radial direction can be reduced.

As shown in FIG. 26, flyer or winding head 79 comprises base portion 80 through which conductor 81 is advanced. Winding head 79 is adapted to carry a plurality of traverse wound multiple tape package 82 which are supported by spindles 83 extending from base portion 80. In FIG. 26, packages 82 contain a traverse wound pair of different tapes 82a' and 82a''. These different pairs of tapes can be simultaneously wrapped about the conductor 81 in an abutting, separated or overlapping arrangement.

WHAT WE CLAIM IS:—

1. A method of wrapping tape material in a helical manner about a length of an elongated structure, the tape material comprising a plurality of individual tapes from at least one tape supply package having a plurality of individual tapes traverse wound thereon, the method comprising steps of:—

a) advancing the elongated structure to be wrapped in a predetermined direction;

b) rotating the or each tape supply package with respect to the line of advancement of the elongated structure;

c) separating each one of the plurality of tapes from the or each tape supply package at a predetermined location on the periphery of the rotating package;

d) guiding each tape of the plurality of individual tapes from the or each tape supply package toward the elongated structure to be wrapped thereabout, each tape being guided for wrapping the elongated structure at a predetermined helical angle with respect to the length of the elongated structure and for

wrapping with respect to the next adjacent tape of the plurality of tapes in either spaced apart or substantially abutting, or overlapping relationship; and

e) wrapping helically the guided tapes on the elongated structure in spaced apart or substantially abutting, or overlapping relationship.

2. A method of wrapping tape material in accordance with claim 1 in which the step of rotating the or each tape supply package comprises rotating the or each tape supply package with the central longitudinal axis of the or each tape supply package disposed along the line of advancement of the elongated structure and wherein each one of the plurality of tapes is separated from the or each tape supply package at a predetermined location on the periphery of the rotating package which is different to the location of separation of the or each other tape.

3. A method of wrapping tape material in accordance with claim 1 in which the step of rotating the or each tape supply package comprises rotating the or each tape supply package with the central longitudinal axis thereof disposed offset from and substantially parallel to the line of advancement of the elongated structure.

4. A method of wrapping tape material in accordance with any one of claims 1 to 3 in which the step of wrapping comprises wrapping the tapes with the tapes spaced apart along the elongated structure by an interval of less than the width of the tape.

5. A method of wrapping tape material in accordance with any one of claims 1 to 3 in which the step of wrapping comprises wrapping the tapes with each tape overlapping the tape adjacent thereto to an extent less than the width of the tape.

6. A wrapped elongated structure obtained by the method of claim 1 and comprising a plurality of individual tapes wrapped adjacent one another in a helical manner along the length of an elongated article with the tapes being spaced apart or abutting, or overlapping relationship.

7. A machine for wrapping tape material in a helical manner about a length of an elongated structure by the method of claim 1, the machine having a winding head, means for driving the head about an axis of rotation of the winding head, the head having an opening extending therethrough along the axis of rotation, means for advancing an elongated structure to be wrapped through the opening in the head in a direction extending substantially along the axis of rotation, a support attached to the winding head for supporting thereon a supply package of traverse wound tape material, a plurality of means attached to the winding head and disposed in circumferentially spaced apart relationship to one another around and adjacent a periphery of the winding head for separating an individual tape of a plurality of individual tapes traverse wound on the tape supply package mounted on the support, each of the separating means causing an associated one of the plurality of tapes to leave the package at a predetermined location adjacent the periphery of the package, the line of travel of each separated tape cyclically varying in direction in response to the traverse winding of the plurality of tapes on the package, and a plurality of guides each for guiding an associated one of the tapes to be wrapped at a predetermined helical angle with respect to the length of the elongated structure and for guiding an associated one of the tapes in spaced apart or substantially abutting or overlapping relationship to the or each next adjacent tape, each of the guides being mounted on the wrapping head circumferentially spaced apart from the or each other guide and being disposed around the axis of rotation of the head at a location axially spaced from the support.

8. A machine for wrapping tape material in accordance with claim 7 in which each separating means comprises a spindle having its length extending substantially parallel to the axis of rotation of the winding head, the spindle being spaced apart from the or each adjacent spindle and being spaced in a radial direction from the axis of rotation of the winding head and having a predetermined circumferential location with respect to the guides, the spindle in use being located adjacent the outer surface of a tape supply package mounted on the support to cause an associated one of the plurality of tapes to leave the package at a predetermined location adjacent the periphery of the package which is different to the location of separation of the or each other tape, the surface of the spindle in use engaging a surface of an associated one of the tapes and supporting the tape during the cyclically varying line of travel of the tape during separation.

9. A machine for wrapping tape material in accordance with claim 8 wherein each spindle is substantially cylindrical along its length and has a circular transverse cross-section with the diameter of the cross-section being maximum at the opposite ends of the spindle and minimum in the central portion thereof to provide a concave surface on the supporting member for accommodating the cyclical varying direction of the line of travel of the associated tape during separation.

10. A machine in accordance with claim 8 or claim 9 in which each spindle is pivotally mounted with respect to the winding head for rotation about the longitudinal axis of the spindle.

11. A machine for wrapping tape material in accordance with any one of claims 7 to 10 in which each separating means comprises an elongated pin for supporting an associated one

of the tapes, the pin extending away from the winding head and the support thereon in a direction parallel to the axis of rotation of the winding head and being disposed adjacent the guides, the surface of each pin along its length being for engaging the surface of an associated one of the tapes and for supporting the associated tape as it travels from the supply package to the guides.

12. A machine for wrapping tape material in accordance with any one of claims 7 to 11 in which each of the guides comprises a guide member having a body portion with an elongated slot extending therethrough for receiving a tape to be guided, the slot having a width substantially corresponding to the width of the tape to be guided, and also comprises means for mounting the guide member adjacent the axis of rotation of the winding head but spaced radially apart from the path of travel of the elongated structure, the length of the slot being disposed at a predetermined angle to the length of an elongated structure to be wrapped which angle is substantially equal to the angle of the helix in which the associated tape is to be wrapped about the elongated structure and the slot extending substantially tangentially to the path of travel of the elongated structure to cause the associated tape to be wrapped about the elongated structure by the guide member as the guide member is revolved by the winding head about the elongated structure.

13. A machine for wrapping tape material in accordance with claim 12 in which each body portion adjacent the elongated slot therein is formed of a material which has a minimal coefficient of friction with the tape material.

14. A machine for wrapping tape material in accordance with claim 12 or claim 13 in which the elongated slot in the body portion of each guide means is an elongated substantially U-shaped slot and in which the entrance end of the slot for receiving a tape to be guided from the supply package diverges outwardly toward edge portions of the guide member, the divergence of the slot providing clearance for the cyclically varying direction of the line of travel of the tape being guided.

15. A machine for wrapping tape material in accordance with any one of claims 12 to 14 in which the mounting means for each guide member pivotally mounts the associated guide member with respect thereto whereby the length of the slot can be disposed at a selected predetermined angle relatively to the length of an elongated structure to be wrapped which angle corresponds to the angle of the helix in which the associated tape is to be wrapped about the elongated structure.

16. A machine for wrapping tape material in accordance with claim 12 in which the mounting means movably mounts the guide member at a selected predetermined position along the length of the path of travel of the elongated structure so that the position of each guide member is in accordance with a desired relative position of engagement of the tapes with the guide members.

17. A machine for wrapping tape material in accordance with any one of claims 12 to 16 in which the mounting means comprises an elongated guiding head mounted on the winding head and having a passage extending through the longitudinal axis thereof and aligned with the opening in the winding head to enable an elongated structure to be wrapped to be advanced through the passage, the guiding head having a plurality of means extending along the length of the guiding head for locating an associated one of the guide members, the guiding head being open between the locating means to provide clearance for tapes travelling from the guide members to the elongated structure.

18. A machine for wrapping tape material in accordance with claim 17 in which the plurality of locating means comprises a corresponding plurality of rods mounted on the winding head and spaced apart from one another along their length, and a plurality of means each slidingly attached to an associated rod and partially coupled to an associated guide member for positioning the associated guide member along the rod.

19. A machine for wrapping tape material in accordance with claim 18 in which the locating means further comprises a pair of circular end plates each having a bore extending axially through its centre, one plate at each end of the plurality of rods, the plates extending parallel to one another and traversely with respect to the length of the rods, the bores therein being in axial alignment for the passage of an elongated structure therethrough.

20. A machine for wrapping tape material in accordance with claim 7 in which the support for supporting thereon a supply package disposes the central longitudinal axis of the supply package along the line of advancement of the elongated structure.

21. A supply package of tape material to be helically wrapped about a length of a structure by the method of claim 1 comprising a plurality of individual tapes of substantially equal length, traverse wound in turns about a longitudinal axis of the package to form a plurality of tubular layers, each layer being wound about the layer previously wound, each tape in a turn of the plurality of tapes in each layer overlapping the next adjacent tape, the overlapping being overlapping of the width of the tape next adjacent thereto by a predetermined amount less than the total width of the tape, whereby the plurality of tapes can be wrapped around a length of an elon-

gated structure without the creation of a surplus or shortage in any of the plurality of tapes.

22. A supply package for supplying tape material in accordance with claim 21 in which each subsequent tubular layer is traverse wound about the layer previously wound and is compressed with respect to the layer previously wound to ensure tightness of the layers of the package with respect to adjacent layers to maintain the package intact during handling thereof and supplying of the tape material.

23. A supply package for supplying tape material in accordance with claim 21 or claim 22 and further comprising a tubular core disposed at the centre of the package and extending along the longitudinal axis of the tubular layers of the package, the core being in contact at its outer surface with the inner surface of the first traverse wound tubular layer of the plurality of tapes, and providing a mount for the package during supplying of the tape material thereon.

24. A supply package in accordance with any one of claims 21 to 23 in which the amount of overlap of each tape with respect to the next adjacent tape being in the range extending from the overlapping of edge portions of the tapes to the overlapping major portions of the total width of the tapes.

25. A supply package in accordance with any one of claims 21 to 24 in which the package has a substantially hollow central portion extending thoughout the longitudinal axis of the package about which the layers thereof are disposed, the inner surface of the hollow central portion providing a mount for the package about which mount it can rotate when delivering the plurality of tapes.

26. A machine for winding a supply package of tape material in accordance with claim 21, the machine having means for supporting the package in rotation as it is being traverse wound, means spaced apart from the supporting means for guiding tape advanced from a supply of tape to a package being wound, and means for reciprocating the guiding means in a direction extending substantially parallel to the axis of rotation of the package supporting means to cause the tape to be traverse wound upon the package, the tape guiding means comprising a plurality of passages each of which is adapted to receive an associated one of a plurality of tapes to be traverse wound in overlapping relationship, the passages in the guiding means extending substantially parallel to one another and being positioned with respect to one another in correspondence to the required overlap, the passages of the guiding means enabling the plurality of tapes to be delivered to the package with a required overlap to be traverse wound to form the package.

27. A machine for winding a supply package in accordance with claim 26 in which each passage of the guiding means comprises a slot for receiving a different one of the plurality of tapes for passage therethrough.

28. A machine for winding a supply package in accordance with claim 26 or claim 27 in which each of the plurality of passages of the guiding means has a width in a direction transverse to the length thereof which substantially corresponds to the width of a tape to be wound.

29. A machine for winding a supply package in accordance with claim 28 in which each passage is tubular and in which the height of each tubular passage is greater than the thickness of a tape to permit passage therethrough but is related to the thickness of the tape to enable the tubular passage to control each tape as it is advanced through the passage.

30. A machine for winding a supply package for supplying tape material in accordance with any one of claims 26 to 29 wherein said tape guiding means has a plurality of passages each of which is adapted to receive an associated one of the tapes for overlapping winding on the package, the overlapping being by an amount less than the total width of the tape, the passages in the guiding means extending substantially parallel to one another and being spaced apart from one another in an offset manner with each passage of the guiding means offset to overlap a predetermined portion of the passage adjacent thereto by an amount corresponding substantially to the amount of the overlap required in the tapes when wound on the package, the passages of the guiding means enabling the tapes to be delivered to the package for traverse winding thereon with the required predetermined overlap.

31. A method of winding a supply package of tape material in accordance with claim 21 comprising the steps of traverse winding a tape to form a plurality of tubular layers, each layer being disposed about the layer previously traverse wound, positioning each turn of tape in a layer during the traverse winding to overlap a predetermined portion of the width of the tape in the turn of tape adjacent thereto, the predetermined portion of overlapping being less than the total width of the tape, supporting the package in rotation as it is being traverse wound, and guiding the tape when being advanced from a supply of tape to a package being wound, the guiding including reciprocating the tape being advanced in directions extending substantially parallel to the axis of rotation of the package to cause the tape to be traverse wound upon the package, wherein an improvement comprises the steps of providing a plurality of individual tapes of substantially equal length to be traverse wound, during the guiding step placing each tape overlapping with respect to the next adjacent tape thereto, the overlapping being

by an amount which is less than the total width of the tape, and during the traverse winding step maintaining the overlapping relationship of the tapes.

32. In a method of winding a supply package for tape material in accordance with claim 31 in which the step of maintaining the overlapping relationship of the tapes comprises advancing the plurality of tapes substantially parallel to one another and spaced apart from one another in an offset manner with each tape being offset to overlap the tape adjacent thereto by a predetermined amount, with the predetermined amount of offset substantially corresponding to the desired overlap of the tapes in the traverse wound package, the advancing of the plurality of tapes enabling the plurality of tapes to be delivered to the packages with the predetermined overlapping of the tapes.

33. A method of wrapping tape material substantially as hereinbefore described with reference to FIGS 1 to 16 or to FIGS. 23 to 27 of the accompanying drawings.

34. A machine for wrapping tape material substantially as hereinbefore described with reference to FIGS. 1, 2, 3, 4, 6 and 7 or as modified by FIG. 5 or as modified by FIGS. 25 and 27 or 26 of the accompanying drawings.

35. A supply package for tape material substantially as hereinbefore described with reference to FIGS. 10 or 11 or 12 or 23 or 24 of the accompanying drawings.

36. A machine for winding a supply package substantially as hereinbefore described with reference to FIGS. 17, 18, 19, 20 and 21 or 22 of the accompanying drawings.

37. A method of winding a supply package substantially as hereinbefore described with reference to FIGS. 10 or 11 or 12 and to FIGS. 17, 18, 19, 20 and 21 or 22 of the accompanying drawings.

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Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1980.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

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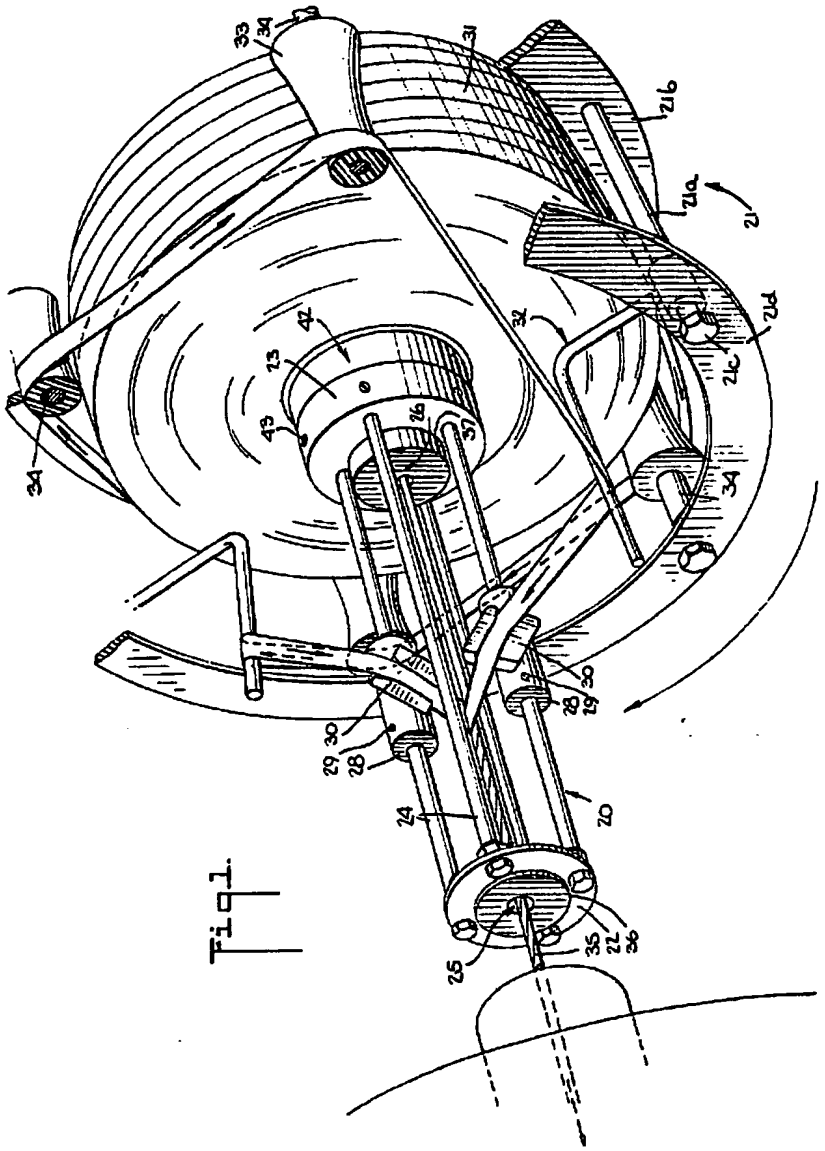

Fig.1.

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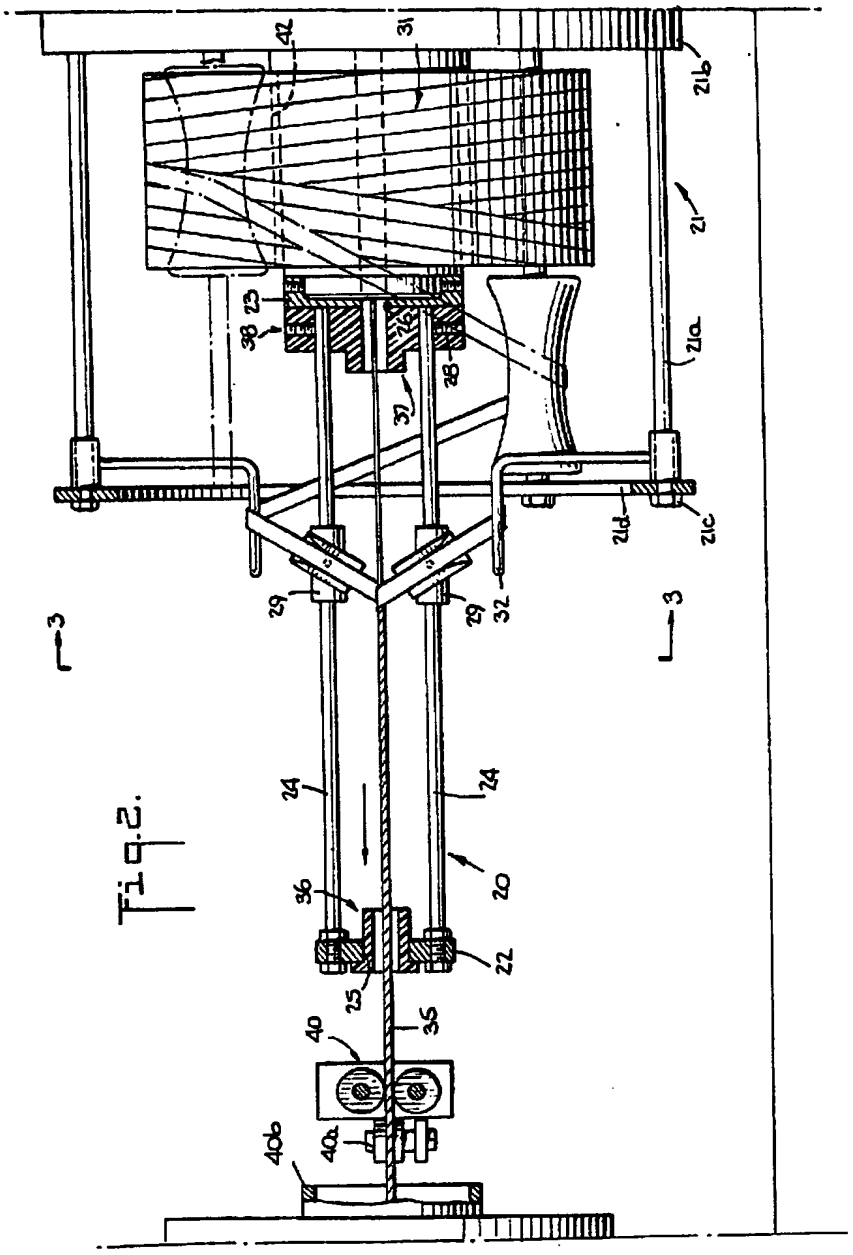

Fig.2.

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Fig.7.

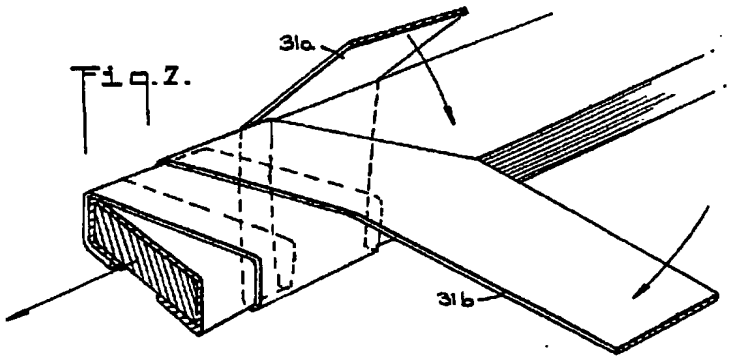

Fig.8.

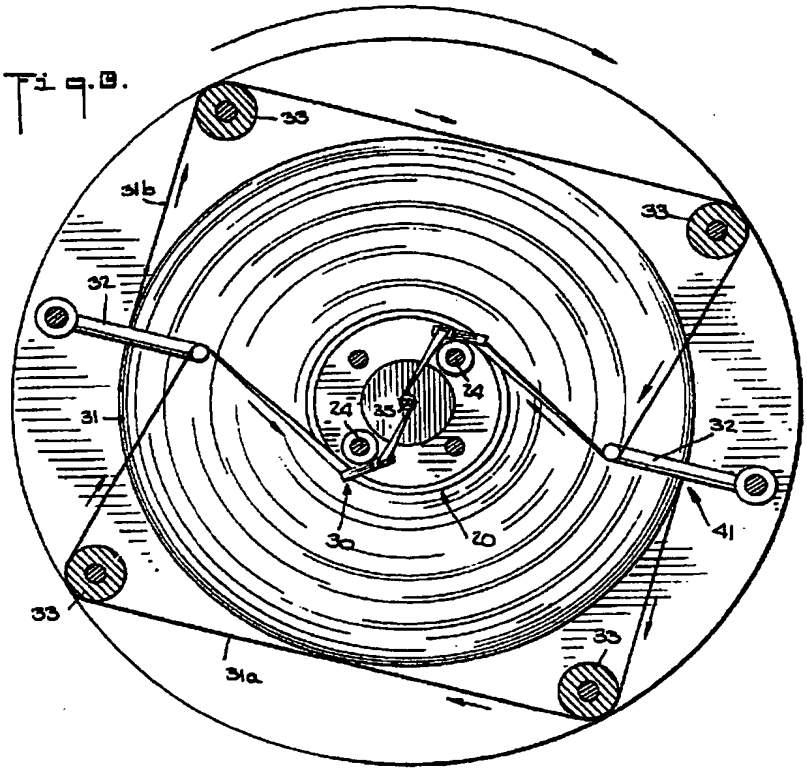

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Fig.4.

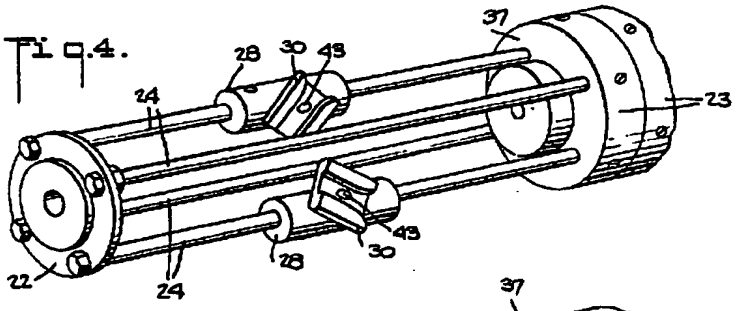


Fig.5.

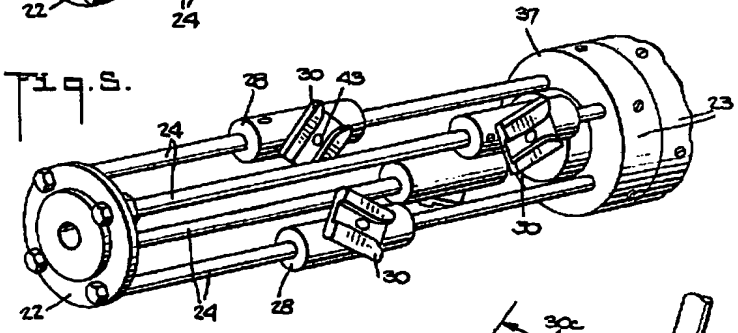
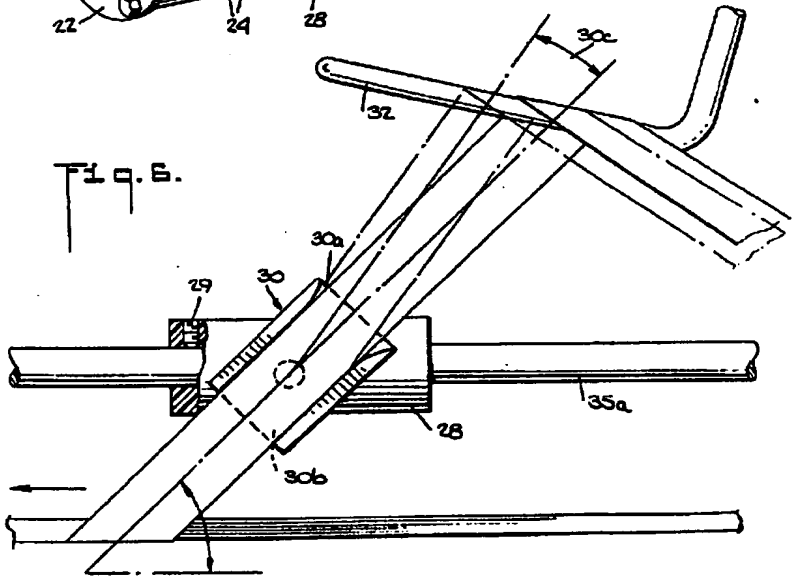


Fig.6.



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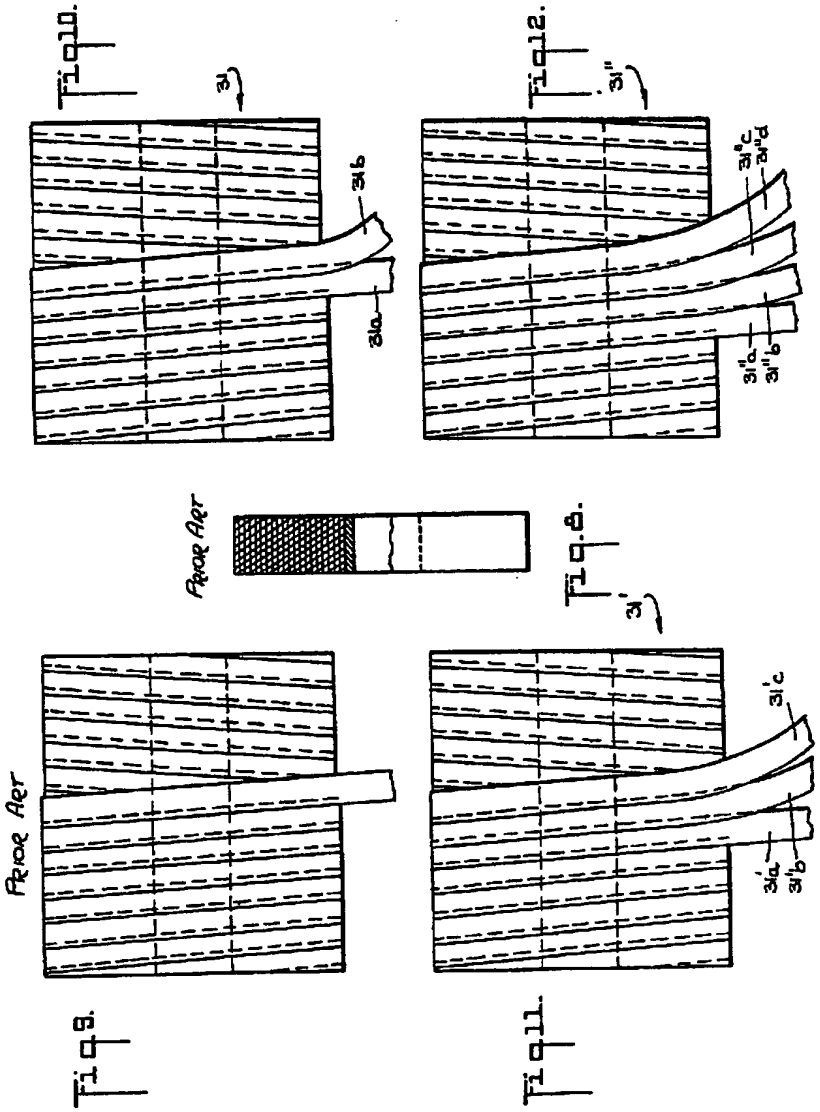

Fig.13.
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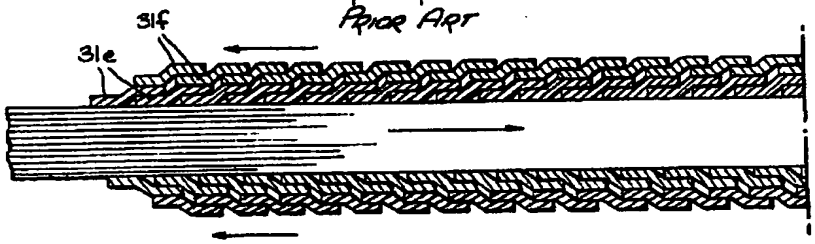

Fig.14.

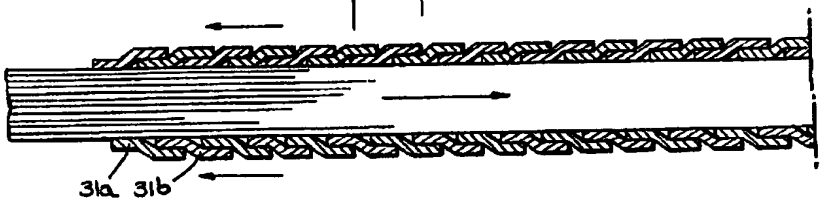

Fig.15.

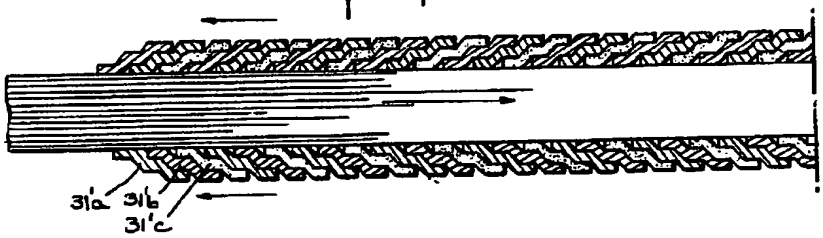

Fig.16.

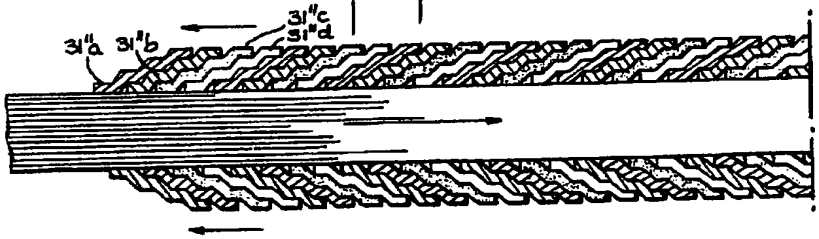

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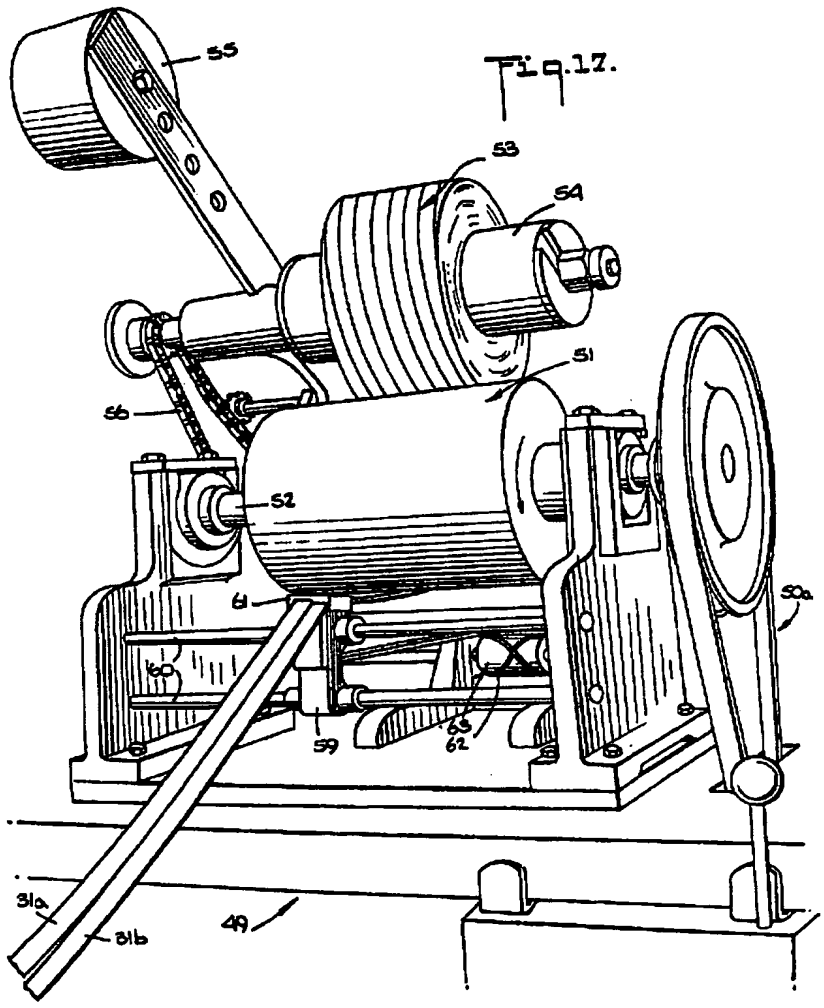
Fig.12.



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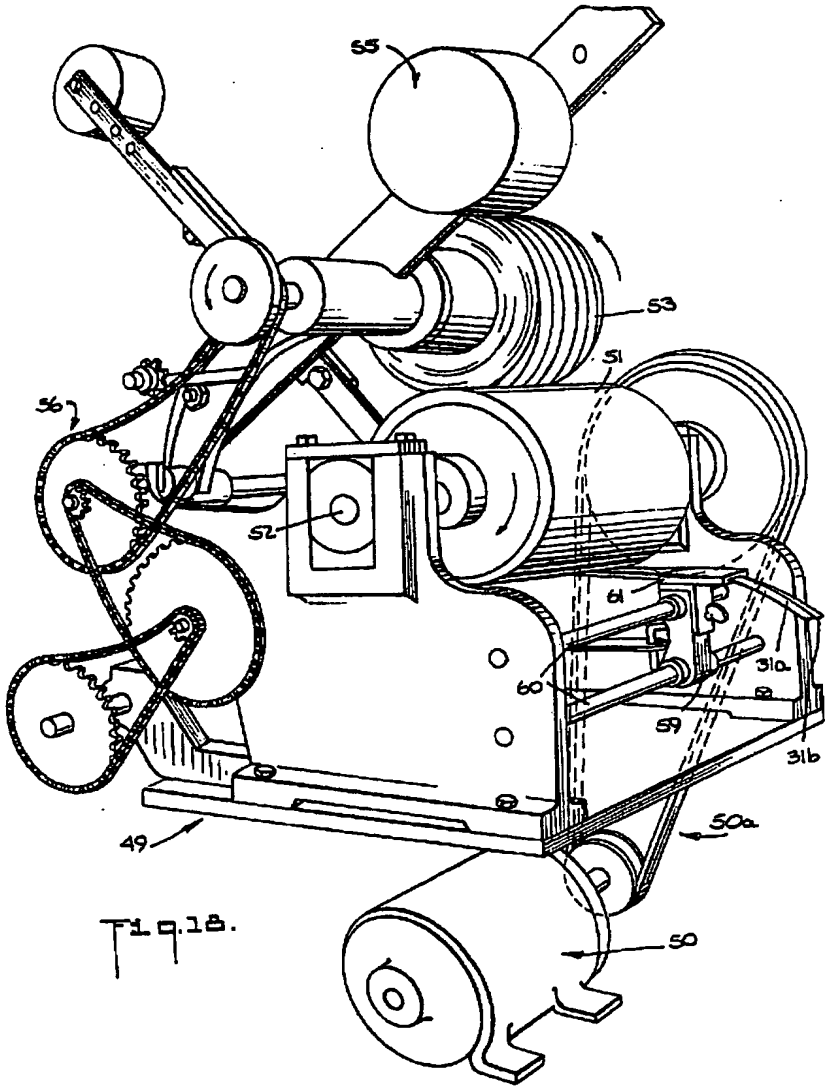

Fig.18.

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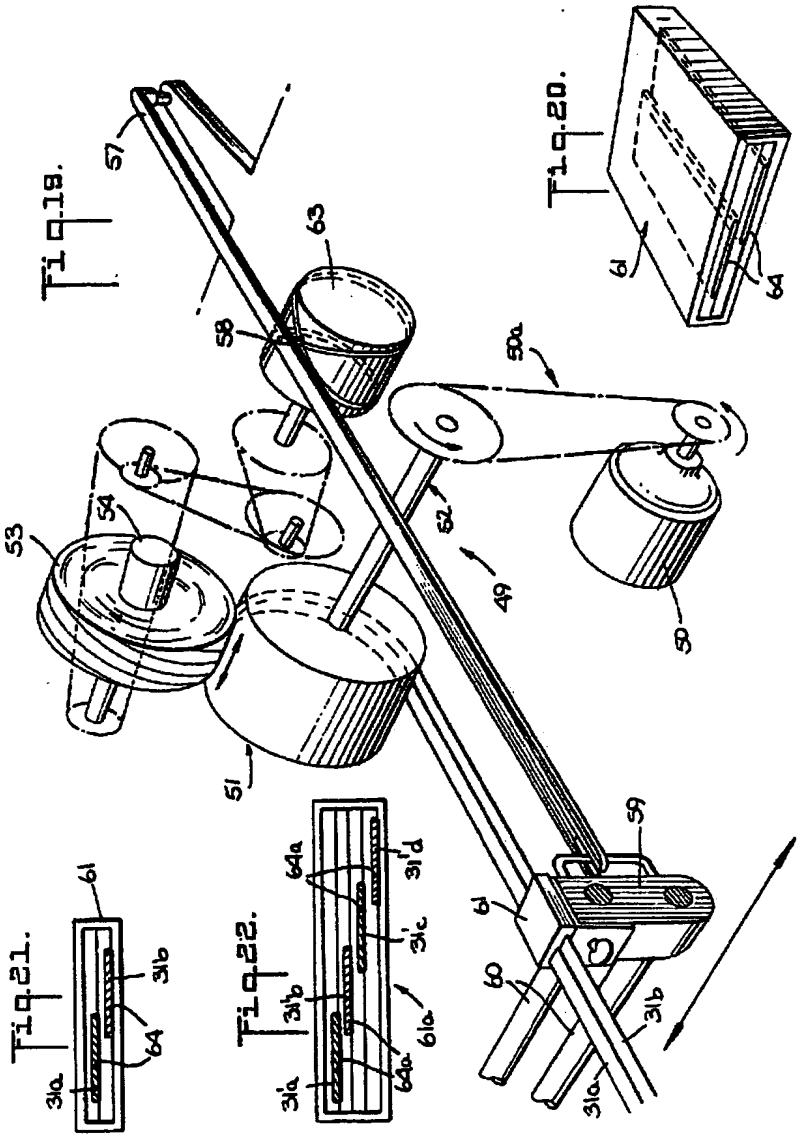

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Sheet 10

Fig.23.

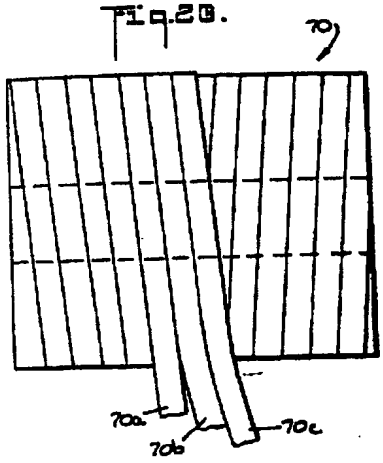


Fig.24.

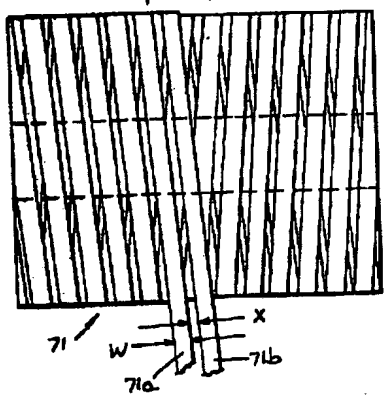


Fig.25.

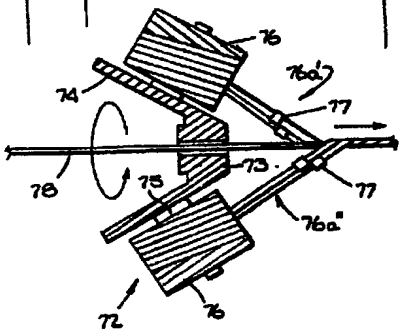


Fig.26.

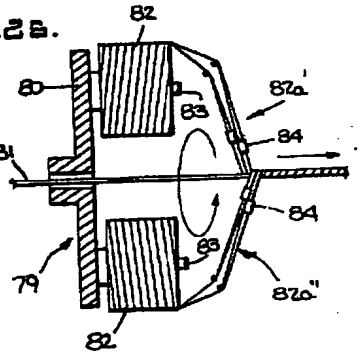
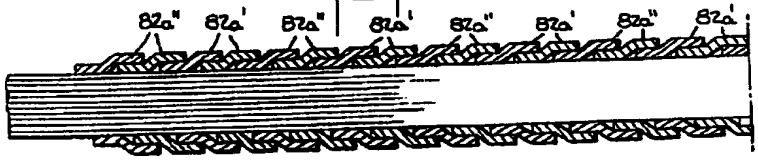


Fig.27.



United States Patent Office 3,273,814 Patented Sept. 20, 1966

3,273,814

ROTATING DISPENSING APPARATUS

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Filed Apr. 1, 1964, Ser. No. 356,602
6 Claims. (Cl. 242—55)

This invention relates to rotating dispensing apparatus and particularly to such apparatus for distributing a continuous strand-like member such as a resin impregnated glass fiber strip or ribbon upon a mandrel to form a tubular member.

Although the present invention may be generally employed for supplying a series of strips or strands of indefinite length as a continuous length, it is particularly adapted for the formation of tubular members and the like by spiral wrapping of a resin impregnated glass fiber strip upon a suitably moving support; for example, as shown in United States Patent 3,099,190 which issued July 30, 1963 to Chester Allen, Jr., et al., entitled Strip Winding Apparatus. The Allen et al. patent discloses a rotating head or spool carrying a supply of a resin impregnated glass fiber strip wound thereon. A cylindrical mandrel is continuously passed axially through the spool with the innermost end of the strip secured to the mandrel. The head is rotated in timed relation to the movement of the mandrel through the head to spirally wrap the strip on the mandrel in overlapping relationship to form a tubular member.

Generally, periodic stopping of the operation is required for replenishing of the material supply on the rotating head. This reduces the efficiency and increases the cost of the wrapping or forming operation.

Further, in the formation of members from resin impregnated glass fiber strips, the rotating head is preferably designed to function with a predetermined maximum and minimum depth of strip convolutions on the winding head. This limits the tape supply which can be provided and increases the frequency of stopping the apparatus for replenishing of the supply.

The present invention is particularly directed to a rotating dispensing apparatus including means to allow replenishing of the supply on the rotating head while the previously stored tape supply is being dispensed. In accordance with the present invention, a plurality of at least three concentric supply spools or reels are mounted for selective relative rotation with respect to each other. The inner reel is rotated in a manner to dispense the material supply thereon. Adjacent reels are threaded conversely to each other, the direction on the respective reels being determined by the takeoff from the innermost reel. In operation, to replenish the supply from an outside source, the outer supply reel is stopped while the innermost takeoff reel and at least the adjacent reel continue to rotate to dispense the tape from the innermost reel. The outside supply is spliced to the trailing tape end on the outermost reel which is then again rotated with the other reels to build up a tape supply on the outer reel. After a predetermined amount of the material is transferred to the outer reel, it is again stopped, the material cut from the supply and the end secured in place to prevent unravelling. Transfer of the tape from the outer reels onto the intermediate and inner reels is accomplished by establishing relative rotation between the adjacent reels.

In the preferred construction for the apparatus, four concentric reels are employed with the three inner reels serving as material supply storage units and with the outermost reel holding the end of the tape carried on the outer supply reel. This eliminates problems of securing the tape end to prevent frayed edges and the like.

The present invention provides a reliable method and apparatus for the continuous feeding of a flexible member of indefinite length and is particularly directed for high-speed continuous winding of a resinous reinforced glass fiber strip or tape for the formation of glass fiber reinforced tubular members and the like with an optimum tape supply on the winding head.

The drawings furnished herewith illustrate the best mode presently contemplated for carrying out the invention.

In the drawings:

FIG. 1 is a diagrammatic layout of a tubular pipe forming system including a winder of the present invention;

FIG. 2 is a diagrammatic illustration of the winding head more clearly showing the functional relationship between the winding heads and the movement of the resinous reinforced glass fiber strip between the several reels;

FIG. 3 is an enlarged elevational view of a simplified winding head structure;

FIG. 4 is a sectional view taken on line 4—4 of FIG. 3; and

FIG. 5 is a vertical section taken on line 5—5 of FIG. 3.

Referring to the drawings and particularly to FIG. 1, a diagrammatic layout of a fiber glass pipe forming assembly is shown in which a plurality of mandrels 1 are secured in end-to-end relationship in any suitable manner, not shown, and passed through a winding head assembly 2 as a continuous winding form. In passing through assembly 2, a spiral wrap of a resin impregnated glass fiber covering 3 is provided and allowed to cure or set and thereby form a reinforced plastic tube member.

The assembly 2 includes a winding head 4 which spirally wraps a resin impregnated glass fiber tape 5 onto the mandrel 1 with the adjacent convolutions partially overlapped as more clearly shown in FIG. 5 to form the covering 3. A tape supply unit 6 is mounted adjacent one side of the winding head 4 to replenish the tape supply to the winding head 4 such that an uninterrupted spiral winding of the tape 5 onto the mandrels 1 can be maintained. From the winding head 4, the covered mandrels 1 are fed to a wrapped mandrel storage or the like, not shown, where they are separated and stored for subsequent handling and processing.

Generally, the illustrated tape supply unit 6 includes a tape reel 7 freely rotatable between suitable bearings 8 and 9 to permit free rotation of reel 7. Tape 10 corresponding to tape 5 is carried by reel 7 and includes an outer free end 11 which is secured to a trailing end of tape 5 as hereinafter described.

Referring particularly to FIGS. 3–5, the winding head 4 of this invention includes four concentrically arranged tape supply reels 12–15, inclusive, with the inner reel being numbered 12 and the outer reel being numbered 15. The reels 12–15 are disposed within an outer protective annular shell 16, shown only in FIG. 1. Resin impregnated glass fiber tape 5 is wound on the three inner reels 12 through 14 as a continuous strip to provide the respective interconnected tape supplies 17, 18 and 19. The trailing end or edge of the tape is secured to the outer reel 15 as hereinafter described.

Within the inner reel 12, a small takeoff roller 20 is provided immediately adjacent and rearwardly spaced from the takeoff point of tape 5 from the reel. The tape 5 passes over the takeoff roller 20 around a suitable idler pivot roller 21 to a distributing arm roller 22 secured to an adjustable arm 23 also carried by reel 12. Roller 22 is set to determine the spiral wrap angle of the tape 5 on the mandrel.

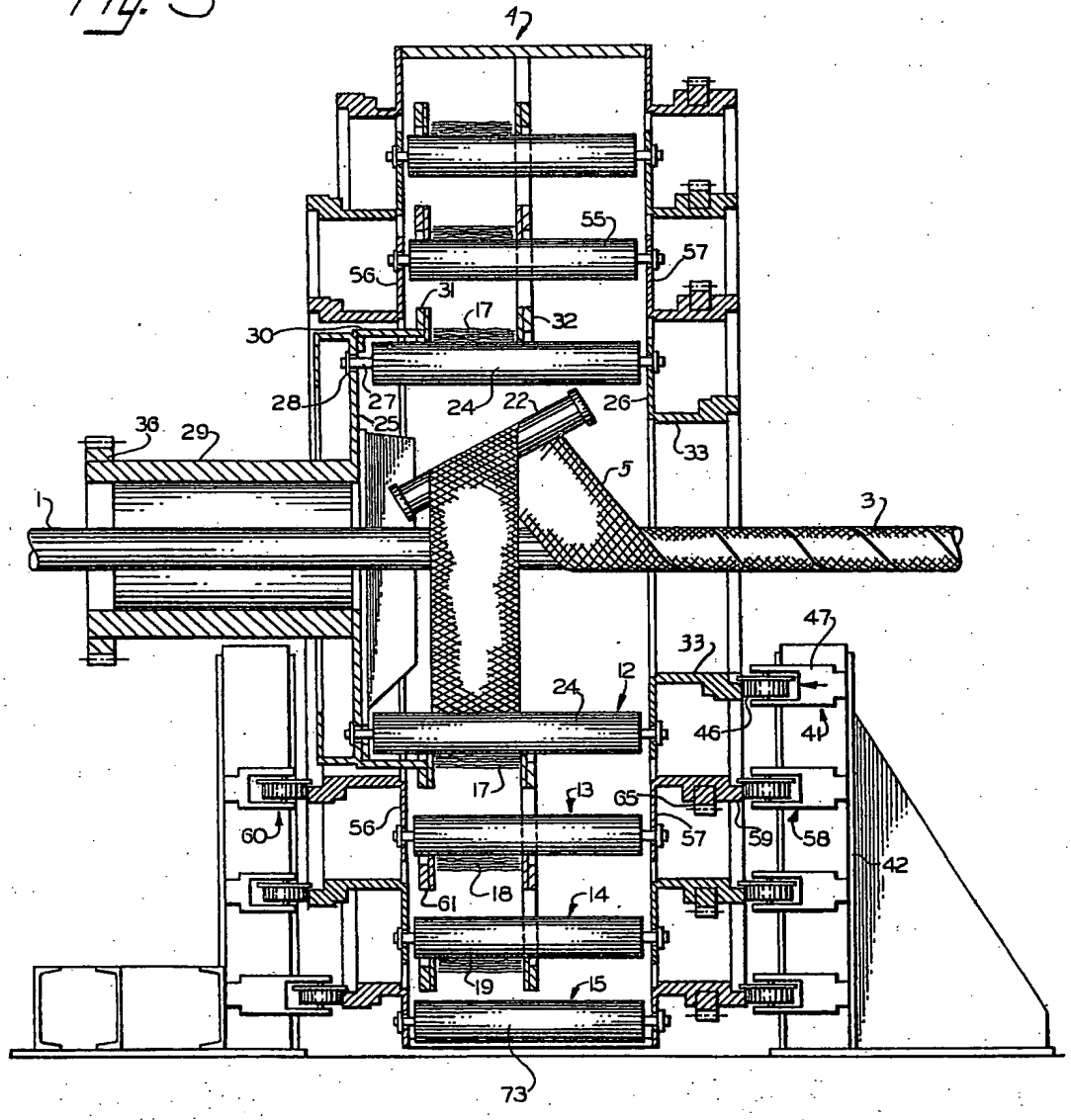
In moving through the head 4, the tape 5 is taken or fed successively from the reel 14 to reel 12 and then onto the mandrel 1 to form the tubular covering and member

Sept. 20, 1966 D. F. PRUSAK ET AL 3,273,814

ROTATING DISPENSING APPARATUS

Filed April 1, 1964 3 Sheets-Sheet 3

Fig. 5



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